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REPORTS ON THE CONTRIBUTION OF SURVEYING, MAPPING AND CHARTING TO SUPPORT THE IMPLEMENTATION OF AGENDA 21: PUBLIC ACCESS TO AND EXCHANGE OF INFORMATION

National Electronic and Multimedia Atlases: A New Cartographic Product for the Information Era**

(Submitted by the International Cartographic Association (ICA))

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NATIONAL ELECTRONIC AND MULTIMEDIA ATLASES: A NEW CARTOGRAPHIC PRODUCT FOR THE INFORMATION ERA

Introduction

The information revolution is having a profound impact on cartography. This paper will consider a new product as an example--the Electronic National Economic Atlas of China (ENEAC) which was produced in CD-ROM form in November of 1996 and which is now commercially available.

Electronic atlases are very much a product of the 1990s and there are a number of examples appearing at various scales. The Electronic Atlas of Canada, which is now online on the World Wide Web, and the Electronic Atlas of Sweden are good examples of this new genre which has great potential for the future. The Electronic National Economic Atlas of China is the first comprehensive and completeelectronic atlas produced by a developing nation and is a truly remarkable product.

The National Economic Atlas of China published in 1994 is one of the most impressive national atlases ever produced in traditional paper format. It is also probably the last major national atlas of its type. The first true major national atlas produced was the National Atlas of Finland published in 1899 at the close of the 19th century. As the 20th century draws to a close it is unlikely that any new major national atlases in paper format will be produced. There are a number of reasons for this. The economics of atlas production in traditional format have changed making the costs of such production exorbitant. More importantly, however, are the technological changes of the information era where the convergence of computer, broadcast and telecommunication technologies and media is revolutionizing cartography and most other aspects of human activity all over the world. We are entering the era of the electronic atlas with an emphasis on dynamism and interaction rather than static map production.

The publication of the National Economic Atlas of China was a remarkable achievement in both relative and absolute terms. It gives a comprehensive graphic picture of the most populous nation on earth and is a major contribution to our understanding of one of the most remarkable economic and social changes of our time--the ongoing transformation of a dominantly agricultural society into a modern industrial economy. The Atlas, however, suffers from the major disadvantage of all products of its type. It was outdated by the time it was published and, in addition, it is essentially a static document.

The Electronic National Economic Atlas of China is an entirely new product and reflects the changes which are taking place in modern cartography. It is new in two important ways. First, the data it contains are new. The remarkable pace of change in China's economy continues with little indication of any significant slow down.

Although China's physical geography remains fairly constant and basic spatial patterns persist almost everything else is changing. The National Economic Atlas of China was published in 1994 but much of the data on which its maps were based were at least five years old. The base data for the Electronic Atlas is from surveys completed in 1993 and much of the data is from 1994 and 1995. Unlike the paper version the format of the Atlas allows easy update at low cost.

The second important way in which the Electronic Atlas is different is the degree of interaction and choice which is open to the user, through the access software developed for the Atlas--EA WORLD. In the paper version of the Atlas all users were constrained by the linear format. Although a user could choose a particular map to view by turning the pages, all users would see the same image on that page. In the Electronic Atlas it is unlikely that any two users will use the Atlas in exactly the same way. The software uses an object oriented approach and is not linear in nature thus allowing great flexibility. Although the software was developed for use with this Atlas it can easily be adapted for use with other electronic atlas projects and is a major contribution to the field of electronic mapping. The importance of a good user interface cannot be over-emphasized.

Visualization (MacEachren and Taylor, 1994)[2] is central to modern cartography. Although visual analysis and communication have always been important aspects of cartography, modern visualization is different in both quantitative and qualitative terms. In quantitative terms many more products, such as electronic atlases can be produced much faster and much more cheaply. This Electronic Atlas, for example, was produced in less than half the time required for the paper product and at a fraction of the cost. In qualitative terms interaction with visual displays can take place in real time greatly increasing the comprehension of the user in a wide variety of subject areas. It is this marked increase in the possibilities for cartographic cognition and analysis which is at the heart of cartographic visualization resulting in an exciting and dynamic cartography with interactive manipulation of spatial data leading to increased understanding of complex situations. The volume of spatial data becoming available is increasing exponentially and the data in this Atlas is an example. To fully use the interface options available with each of the 250 maps would take countless hours of continuous use. The paper Atlas was designed to be comprehensive and to be used in a comprehensive way. The Electronic Atlas is designed to be even more comprehensive in terms of information but to be used in an selective way with the user focussing in on topics of special interest. In a paper atlas the user gets only what the cartographer chooses to display. In an electronic atlas the user can go well beyond the images displayed and in some instances to the original data from which the images were compiled.

Scale is also no longer as major a constraint in the electronic era. The possibility of zooming in on areas of special interest at

larger scales now gives much more flexibility although there are still, of course, limitations on how much scale change can be achieved without an unacceptable loss of accuracy. In the Electronic National Economic Atlas of China the zoom function is particularly useful for thematic data at the county level.

This Atlas is produced on CD-ROM but already a growing volume of map information is being made available to users on the World Wide Web. In September 1994 selected elements of the National Electronic Atlas of Canada were made available on the Web and within a month over 60,000 users from over 40 countries had accessed the images (Taylor 1995)[3]. As the information superhighways form and expand, direct delivery of map and spatial information into the home will become more common.

Another major tool is the development of multimedia electronic atlases in which a wide variety of media such as sound, music, film and animation can be integrated with the map data in new and exciting ways. There are already a number of such atlases on the market.

Data Sources

The wealth and volume of information that the atlas contains on China is unique. Seven major sources of information have been used to compile the data for the Atlas. The most authoritative data on population in China is the Fourth National Population Census of 1990. The data are of a high level of quality and accuracy and are available at the county level for rural areas and at a larger scale within China's major cities. Also available at the county level are data from China's Rural Social Economic Statistics from a major survey held in 1993. For each county 190 indicators of the rural economy and agricultural production have been collected. For each of China's cities information is available on over 370 indicators on economic and social development and the rapid expansion of urban construction. Much of the basic information is from 1993. China's industrial sector is growing in size and complexity and there are important changes in ownership and structure as the socialist market economy develops. Data for 1995 for the ongoing National Tertiary Industry Survey have been used for the Atlas and these have been complemented by the latest statistics on an enterprise by enterprise basis of all of China's large and medium scale industrial enterprises. Much of thedata is from 1993 and includes production and investment statistics. This Atlas also utilizes the Statistical Yearbooks of China for the related provinces, autonomous regions and municipalities under the direct administrative control of the Central Government published by the National Statistical Bureau. A final major major source of data for the Atlas is special survey statistics produced by individual ministries on health, education, scientific research, foreign trade, post and telecommunications, rail traffic and environmental protection.

Each of these data sets is important in its own right but their combination and presentation in spatial format greatly increases their value and utility and the data base available in the Atlas is by far the most comprehensive data base available on China in digital format. As the data have been coded and organized in spatial format, comparisons and combinations of different data sets by spatial units as detailed as individual counties are relatively easy. The format ofthe Atlas also allows update on an annual basis and the Atlas will be regularly updated, initially on a biennial basis.

Atlas Content

There are ten topic sections in the Atlas which has over 250 map themes and over 1000 graphs, diagrams, indices and accompanying materials. The ten sections cover:

1. Administrative Divisions and Topography
2. Resources
3. Population
4. General Economy
5. Agricultural and Rural Economy
6. Industry--which is the largest single component of the ENEAC
7. Transportation, Post and Telecommunications
8. Buildings, Urban Construction and Environmental Production
9. Trade, Commerce, Financial Institutions and Tourism
10. Education, Scientific Research, Culture and Sports

The data base is large, taking up between 300 and 400 megabytes of computer memory.

Hardware Requirements

The atlas is designed to run on a PC in a Microsoft Windows environment. Requirements include 4 megabytes on memory, 120 megabytes of hard drive on 8 bit VGA adaptor with 256 colours and a colour screen monitor with a resolution of 768 X 1024. Hard copy requires a colour laser or ink jet plotter for best results.

Software

Access to the information in the Atlas is through a software package called EA-WORLD which is an integral part of the Atlas package. The software was developed indigenously in China by the Institute of Geography of the Chinese Academy of Sciences. An object oriented approach was used using a modified Hypertext concept. A detailed description of the approach used can be found in Taylor, Liu and Chu' and is beyond the scope of this paper. Utilizing the query and display function of EA-World which is knows as EA-Viewer, the main functions are:

1. Map display and zoom in and out
2. Map roam
3. Map display by theme or two map contrast display

4. Dual direction query and multiquery; retrieving cartographic indices by geographic position or obtaining spatial distributions through logical expressions of cartographic indices.
5. Display of st tistical data by theme
6. Selected thematic data output to printer
7. Hard copy of maps through printer
8. The retrieval and output of explanatory Atlas text and notes

Conclusion

The Electronic National Atlas of China is a major contribution to the field and is a clear example of China's interest in the information era. The Atlas was conceived, developed and produced in China utilizing indigenous sources and expertise. The Atlas is a tribute to the ingenuity, skill and expertise of Chinese cartographers. It provides in a remarkable way a picture of a remarkable nation undergoing an economic and social transformation of unparalleled scale and significance. For nearly two decades the economy of China has developed on an average growth rate of over nine percent. This far exceeds the growth rate of the nations of Western Europe during the Industrial Revolution and is much more impressive and sustained than the more recent "Japanese Economic Miracle" of the 1950's and 1960's. Growth is, of course, not without its problems, including growing interpersonal and spatial disparities which the Atlas reveals, and a rise in inflation rates which detracts from overall growth. Population growth rates, although modest in percentage terms, are significant because of the large population base. An added concern is that the rapid pace of industrialization is causing a loss of farm land which may have adverse effects on food production, which is vital to China's future. Although these cannot be ignored, the picture which emerges from the Atlas is of a nation poised to be a major player on the world scene for the 21st century.

China has indicated to the developing world what can be achieved in terms of electronic atlas production. ENEAC is a sophisticated interactive produce with an immense and comprehensive data base on China's economy. The next generation of atlases of this type will be full multimedia products. A good example is Canadian Geographic Explorer which was produced by a consortium of government and private sector enterprise. The CD-ROM utilizes maps, photography, video, text, remote sensed imagery and digital terrain models. Explorer is designed for the general public and makes imaginative use of sound and imagery including the first 3D remote sensed imagery and the CD-ROM comes with special viewing glasses. ENEAC is a sophisticated product but is designed for the knowledgeable user. Explorer can be used by novice and expert alike and is an excellent method of informing the general public of the geography of a nation in an inexpensive and usable form. It is interactive and allows full scope for user choice but at the same time is structured so that the user has a definite path along which to navigate and make choices. The CD-ROM will persist as a delivery mechanism for new forms of atlases for some time but increasingly products will become available on networks such as the INTERNET.

These networks are likely to be supplemented by new forms such as INTRANETS and EXTRANETS which some national mapping agencies may wish to explore in terms of delivering products to their customers. The map, in new forms, will remain central to the information era.

Notes:

1. The author would like to acknowledge the generous support of the Max Bell Foundation, Toronto, Canada which made his participation in the Atlas possible.

2. MacEachren, A. J. and D. R. F. Taylor (eds), (1994) Visualization in Modern Cartography, Volume 2 in Modern Cartography Series (D.R.F. Taylor, series ed), Oxford, New York, Tokyo: Elsevier Science, pp. 345.

3. Taylor, D. R. F. (1995) Presidential Address to the 10th General Assembly of the International Cartographic Association, Barcelona, Spain.

4. Taylor, D. R. F., Liu Yue, Chu Shiqiang (1996) "EA-World: An object oriented software package for the design and use of hypermedia electronic atlases, Institute of Geography, Chinese Academy of Sciences, Beijing, People's Republic of China.